

The University of Chicago

SUMMARIZED ACCOUNT
OF THE PLEISTOCENE GEOLOGY
OF THE LOWER ILLINOIS
RIVER VALLEY

A PART OF A DISSERTATION SUBMITTED TO
THE FACULTY OF THE DIVISION OF THE
PHYSICAL SCIENCES IN CANDIDACY FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF GEOLOGY AND PALEONTOLOGY

1935

By
TOWNER B. ROOT

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The region covered in this paper is the lower portion of the valley of the Illinois River, from Peoria to its mouth, including the bluffs and hinterland back for a distance of 1 to 2 miles. It will hereafter be called, for convenience, the lower Illinois Valley.

Much work has been done on the Pleistocene geology of various portions of it. The geology of the Peoria Quadrangle was mapped and described by Udden,¹ and Bevan² has mapped the geology of the Glassford Quadrangle. The geology of the Havana and Beardstown Quadrangles has been mapped and described by Wanless³ and Searight.⁴ The geology of the Rushville Quadrangle was mapped by Willard,⁵ and that of the Griggsville Quadrangle by Bell and Branson;⁶ while Rubey⁷ has mapped and described the geology of the Hardin and Brussels Quadrangles, at the mouth of the valley.

The writer did detailed geologic mapping in the intervening quadrangles, Arenzville, Meredosia and Pearl, including both the Illinois Valley itself and an adjacent strip 1 to 2 miles wide at each side. He mapped in detail the geology of a similar por-

¹J. A. Udden, "Geology and Mineral Resources of the Peoria Quadrangle, Illinois," United States Geological Survey Bulletin 506 (1912).

²Arthur Bevan, manuscript map in files of Ill. State Geol. Survey.

³H. H. Wanless, manuscript in files of Ill. State Geol. Survey.

⁴W. Searight, manuscript in files of Ill. State Geol. Survey.

⁵Bradford Willard, manuscript map in files of Ill. State Geol. Survey.

⁶A. H. Bell and C. Branson, manuscript maps in files of Ill. State Geol. Survey.

⁷W. W. Rubey, manuscript in files of Ill. State Geol. Survey.

tion of the Rushville Quadrangle as well, and also made a reconnaissance study of the other previously mapped areas, in order to familiarize himself with their more important features. Least work was done in the Hardin and Brussels Quadrangles, where, however, the writer had the privilege of visiting many of the most significant localities with Rubey. The details of the Pleistocene geology of these two quadrangles will be found in Rubey's manuscript, and only the outlines of such portions as affect the history of the rest of the lower valley will be presented in this paper.

The field work was done in the summers of 1929, 1930, and 1931, as a part of the study of the geology and mineral resources of the lower Illinois River valley, for the Illinois State Geological Survey, under the direction of M. M. Leighton, Chief of the Survey, and the supervision of J. E. Lamar of the Survey staff. The Pleistocene geology presented in this paper proved to be in many respects the most interesting phase of the project. Several short excursions have been subsequently made to the field in the course of organizing and describing this topic, to verify and augment data previously obtained.

This paper constitutes only a brief and generalized summary of the material on the subject, which is covered much more exhaustively in the author's dissertation for the degree of Doctor of Philosophy, of which there are three copies in the library of the University of Chicago. In this dissertation the evidence for the statements made in this paper is more fully presented. The most significant sections and exposures are described and discussed in detail, and many maps and diagrams are included.

GENERAL DESCRIPTION OF THE ILLINOIS VALLEY

The Illinois Valley has a length of some 140 miles from Peoria to its mouth. The breadth of its bedrock gorge varies greatly, and curiously, it is narrowest near the upper and lower ends of the region described. The upper constriction is the bottle-neck a mile south of Bartonville and Wesley, and about 4 miles southwest of the business center of Peoria, where it is slightly less than 2 miles from one rock wall to the other. Next narrowest portion is at Brussels, a little above the mouth of the Illinois Valley, where the walls are slightly less than $2\frac{1}{2}$ miles

apart. The valley widens below Peoria until it reaches a width of nearly 20 miles from bluff to bluff in the area occupied by a great terrace of Bloomington outwash sand (the Pekin-Chandlerville terrace) in Tazewell and Mason counties. Below the mouth of the Sangamon River, it is somewhat narrower, varying from 6 to 10 miles across, and decreasing in breadth below Meredosia to Oxville and Valley City, in Scott and Pike Counties respectively. In this area there are also extensive sand terraces or bars in the valley. Thence southward to Brussels it maintains a breadth of less than 5 and for the most part less than 4 miles.

The surface of bedrock in and near the valley appears to be gently rolling, with broad depressions which cross it in a general east-west direction. These probably slope eastward, since they are far shallower and less marked at the west side of the valley. The most evident one is a sag between Arenzville and Bluff Springs, in which no exposure of bedrock could be found. The Pekin-Chandlerville terrace between the Sangamon and Illinois Valleys apparently occupied another. Many smaller valleys in the bedrock, comparable in size, length and location to the present small tributaries, are outlined somewhat indistinctly by the distribution of outcrops in and back of the bluffs. They indicate a degree of dissection broadly similar to that of the present topography. The total relief was probably not much greater than at present, and may have been somewhat less, since bedrock is now widely exposed in the lower portions of the stream valleys. In the lower courses of the largest valleys, however, the older drift has been cut through and bedrock trenched into, during post-Illinoian times, with subsequent filling by Wisconsin alluvial and valley train material.

PRE-ILLINOIAN HISTORY

The present Illinois River appears to be too small for the valley it occupies. It is flowing at an unusually low gradient, and seems to be effecting little erosion of the valley walls. Leverett¹ explains these circumstances on the grounds that it was pre-Illinoian course of the Mississippi River from Hennepin southward, which was diverted to its present channel as a result of the

¹Frank Leverett, "Outline of the Pleistocene History of Mississippi Valley," Journal of Geology, XXI (1921), 615-626.

Illinoian glaciation.

The oldest definite sedimentary record of the Pleistocene in the region is early Kansas or pre-Kansas silt and sand which outcrops in the Meredosia, Arenzville and Chandlerville Quadrangles. It occurs at elevations of from 505 to 550 feet, indicating a relief of at least that range. Streams were not active enough to cut far into the earlier drift or bedrock, however, since no coarse material was found in it. The gastropod fauna as reported by Curator F. C. Baker¹ of the University of Illinois Natural History Museum, who studied all gastropod faunas described in this paper, includes only land types, and is exactly like that of today except for one extinct form. Depositions of this material appears to have been terminated abruptly by the arrival of the Kansan ice front, which covered it with till before there was time for any of it to be deeply weathered.

The Kansan stage is recorded by till which ranges in elevation from 490 to 560 feet. It is particularly widely exposed in Brown County, where it may have constituted moraines, and it also occurs in Pike, Schuyler, Fulton, Scott, Morgan and Cass Counties. The upper portion of the till is leached to a depth of at least 6 feet below the overlying Yarmouth silt. Whether the glacier came from the northwest or the northeast, or both at different stages, is in doubt. It is also possible that some of the pre-Illinoian till is of Nebraskan age.

A long interval after Kansan glaciation and before deposition of the Yarmouth beds is indicated by the deep leaching of the Kansan till. The Yarmouth beds are widespread, outcropping from Jersey to Cass and Fulton Counties. The range in elevations at which they occur, from 475 to 607 feet, indicates a relief similar to that of the present. In Greene and southern Pike Counties, south of the occurrence of the pre-Illinoian till, the Yarmouth lies directly upon bedrock, or grades downward into a reddish brown residual clay of unknown but probably early Pleistocene or late Tertiary age, which overlies bedrock. Elsewhere it overlies pre-Illinoian till in most exposures.

The Yarmouth beds consist typically of non-calcareous, compact, non-bedded, vari-colored silt, occurring as a mantle usually less than 10 feet thick, at elevations varying from 503 to 607

¹F. C. Baker, Reports to Illinois State Geol. Survey and personal communication, 1929-1933.

feet. The lower portion, and in many exposures the whole of the Yarmouth zone may include sand, pebbles, wood fragments and gastropod shells. This phase is commonly calcareous to a highly variable extent, and thicker than the typical silt. It occurs at somewhat lower elevations, ranging from 475 to 572 feet. Its gastropod fauna includes fresh water forms, and indicates flood plain deposition. The more widespread and typical silt phase which lies on the hills and higher slopes appears to be a loess mantle, which was leached and iron-stained before burial by Illinoian drift. The source of the dust is unknown.

THE ILLINOIAN STAGE

Illinoian ice, coming in from the northeast, covered the entire region southward as far as Pearl at the west side of the Illinois Valley, and the valley of Otter Creek at the east side. Between these places, its border lay in the present Illinois River flood plain. A large outwash plain formed at its edge on the upland southwest of Pearl, on what is now Old Pearl Prairie. The silt, sand and gravel which were deposited there attain a thickness of over 125 feet, and appear to have settled in waters ponded between the ice edge and a bedrock ridge to the west, across which there was a narrow outlet col into the Mississippi River drainage. The great gullies now being cut by streams at the east side of Old Pearl Prairie are one of the most striking sights of the Illinois Valley.

The ice border south of Pearl lay along the west bluff of the valley for a distance of at least 12 miles, and sent small projections into the mouths of the larger tributaries. In five of the latter, small outwash deltas were built up, in each case between the ice lobe and the north wall of the tributary valley. In three of these valleys, the deltas are in pairs, a smaller one to the west of a larger one, indicating two different stages in the position of the ice front, perhaps with a retreat between. These valleys also contain deposits of gray silts which settled in the waters ponded by the ice wall, and in many places glacial erratics, apparently berg-borne.

The Illinoian drift is commonly from 20 to 50 feet thick. Its surface is undulating, except near the Illinois Valley, where there are many short, shallow valleys corresponding to similar but

deeper features of the bedrock surface, and where ravines and gullies of Wisconsin and younger age have been cut into it. It ranges in elevation from 442 to 660 feet, indicating a pre-Illinoian topography which had relief much like that of the present.

The Illinoian till appears to consist of three sheets. In many exposures, the main body of the till contains a zone of outwash near the middle which divides it into lower and upper, older and younger sheets, apparently representing two advances of the ice with a period of partial retreat between. The upper surface of the upper sheet has been leached to a depth of 6 to 8 feet below the overlying late Sangamon loess. Gumbotil has developed in the leached zone in many places, most of which are on the upland, well back from the bluff. No leaching and only one or two inches of local oxidation appear at the top of the lower sheet, and the intervening outwash is unweathered; so that no great time gap is recorded between the two tills.

The lower portion of the lower till is in most exposures darker than the light grayish blue color of the remainder. This dark portion contains fewer and smaller pebbles, has a silty instead of clayey texture, and bears gastropod shells and wood fragments. It greatly resembles the underlying Yarmouth silt, probably because it includes much of that material which was picked up by the early Illinoian ice.

In several exposures in Brown, Fulton, Morgan and Cass Counties, there is another till sheet below the dark, silty lower Illinoian. This underlying till is oxidized in the upper portion, and in some cases the upper few inches are leached. In one outcrop, it overlies typical Yarmouth silt which in turn lies upon leached pre-Illinoian, presumably Kansan till. Thus it appears to be Illinoian, and to represent an early advance of the Illinoian glacier which was followed by melting back and weathering of the drift through thousands of years before the advance which formed the main portion of the drift. The name Morgan is proposed for this till, from the county in which two excellent exposures were found.

There are Illinoian moraines in the southern part of the drift-covered area, but they are inconspicuous as compared to those of the Wisconsin drift. The terminal moraine, as seen near Pearl, is poorly defined; but two groups of recessional moraines in Pike, Brown and Schuyler Counties are distinct enough to be

described and named. The older is the Versailles, which extends from Frederick township in Schuyler County southwestward through northeastern Brown County and thence westward out of the area. It is well developed in Brown County, where four parallel ridges may be distinguished, and there is much associated outwash, as there is in southern Schuyler County. It appears reasonable to correlate the upper Illinoian till sheet tentatively with the ice front which formed this moraine. The younger moraine group is the Florence, which lies near the Illinois Valley at its western side, between Chambersburg and Pearl. It is far less distinct than the Versailles, which may swing back into it from the west at Montezuma; but there is much associated outwash. A large part of the silt, sand and gravel in Old Pearl Prairie came from the ice which made it, as did the Chambersburg outwash plain in northern Pike County. It represents a protracted stand of the ice front along the bluffs at the west side of the Illinois Valley, and may correspond to the eastern Illinoian deltas in each of the valleys south of Pearl.

Exeter ridge, in northwestern Scott County, is a feature of the Illinoian drift plain which may be either esker or moraine. It is about 3 miles long, runs in an east-west direction, is serpentine in plan and nearly level-topped. At its eastern end lies the only good exposure of the materials, here gravel dipping westwards. Wells along the top penetrate sand and gravel, to a total thickness of 45 feet in one case, below the mantling loess. The ridge lies at right angles to the Florence moraine 6 miles west of its western end, indicating that it is an esker. On the other hand, a fairly distinct depression which resembles a fosse parallels it on the northern flank, so that it might also be a moraine formed at the edge of a body of ice lying to the north.

THE SANGAMON STAGE

After the withdrawal of the Illinoian ice, erosion began to degrade the drift surface, particularly near the larger streams. A large mass of Illinoian flood plain and outwash material in the lower Illinois Valley and also in the Mississippi Valley in the vicinity of St. Louis temporarily regulated the depth to which the cutting extended, resulting in the formation of an erosion surface at an elevation of between 520 and 540 feet, herein named the

Apple Creek level. It has been almost completely obliterated by subsequent erosion at lower levels, and is preserved only in the valleys of a few of the larger streams. The loess mantle which covered it later has also obscured it somewhat. Eventually the Illinoian barricade downstream was washed away, and erosion progressed at base-levels comparable to those of the present.

In early post-Illinoian time, drift of Illinoian age evidently blocked the mouth of Crooked Creek, in Schuyler and Brown Counties, with the result that its waters flowed southward across Cooperstown township, in Brown County, through a swale between two of the ridges of the Versailles moraine, to the valley of Little Creek, through which they passed into the Illinois Valley. They cut a striking channel, the Cooperstown Coulee, which was later abandoned as the drift dam was worn away, releasing Crooked Creek to its present course. The coulee has since been filled by late Sangamon and Wisconsin loess, by early Wisconsin alluvial loessial silts of local origin, and, in the upper end, by river borne gray and pink silts of Bloomington age.

The late Sangamon loess is the next unit in the sedimentary record. Since it overlies Illinoian till which has been leached to a depth of 6 to 8 feet, it was not deposited until a long post-Illinoian interval had elapsed, and hence late in the Sangamon epoch. It was evidently preceded by a long period of erosion earlier in the Sangamon interval, at base-levels similar to those of the present, since it lies at elevations of from 490 to 695 feet. It occurs from one end of the area to the other, but is not present in all exposures, indicating that in many places erosion removed it before the Wisconsin was deposited. Its compact, non-bedded, silty character and widespread vertical and horizontal distribution indicate plainly that it is a loess. The fact that it is deeply leached, in contrast to the calcareous lower portion of the Wisconsin loess, and that locally a soil zone appears in it below the latter,¹ shows that much time elapsed between its deposition and that of the overlying material, and that it is not latest Sangamon or early Wisconsin in age. The source of the loess is not known.

¹M. M. Leighton, "A Notable Type Pleistocene Section: The Farm Creek Exposure Near Peoria, Illinois," Jour. of Geol., XXXIV (1926), 167-174.

THE WISCONSIN STAGE

The Wisconsin loess.--The advance of the ice in the earliest (Iowan) substage of the Wisconsin did not reach the lower Illinois Valley; and there is no outwash of Iowan age identifiable there. The loess associated with it, however, extends throughout the lower Illinois Valley, where it is called Peorian. At Peoria, this loess underlies the Shelbyville and Bloomington drift, which is covered by a younger but somewhat similar loess, 6 to 12 feet thick, properly called the Tazewell.¹ South of the edge of the Shelbyville till-covered area, the Tazewell directly overlies the Peorian, forming a single unit, referred to herein as the Wisconsin loess. In many places it seems impossible to distinguish the two since there does not appear to be any pronounced zone of weathering or other break between them. At the east side of the Illinois Valley, and north of Mauvaise Terre Creek, however, there is a sandy zone in the middle part of the loess. The Bloomington valley train in the Illinois Valley to the west is the obvious source of the sand, which is fine, fresh and calcareous, and interbedded with the loess. In most places it is covered by soft, calcareous, grayish to yellow loess. Thus it is probable that the sand zone and overlying loess are of Bloomington age, and not much younger, since farther to the north and east the younger or Tazewell loess, is found associated with the Bloomington or older Wisconsin drift, and not with the Marseilles or younger ones.² The underlying loess is probably largely Peorian, although it may include Shelbyville material.

Loess of late Bloomington age also mantles the terraces of pink and gray silt which are slack water portions of the Bloomington valley train formed in the mouths of many large tributary valleys. This loess is very similar in character and depth of leaching to that covering the Bloomington and Shelbyville drift near Peoria; and also to fresh seeming loess overlying early Wisconsin alluvial silts in several places.

¹George F. Kay and M. M. Leighton, "Eldoran Epoch of the Pleistocene Period," Bulletin Geol. Soc. of America, XLIV (1933), 669-673.

²M. M. Leighton, "The Peorian Loess and the Classification of the Glacial Drift Sheets of the Mississippi Valley," Jour. Geol., XXXIX (1931), 45-53.

The loess literally covers the region like a blanket, and is lacking only in stream valleys, where it has been removed by erosion. Even much of the alluvium in the valleys is loessial silt from higher slopes and uplands. The blanket is thickest near the Illinois Valley, and somewhat thicker at the eastern than at the western side. It thins away from the valley walls to such a degree that there is a definite slope of the upland surface away from the bluffs. It also tends to decrease the relief of the topography and diminish the gradient of slopes which it mantles. It forms steep-sided knobs over bedrock headlands along the Illinois Valley bluffs, and stands in nearly vertical faces in road and stream cuts. Where it contains much interbedded sand, it is characterized by a somewhat subdued dune topography, well displayed in parts of Cass, Morgan and Scott Counties.

The thickness of the loess varies from 20 to 80 feet at the east side of the valley, and from 15 to 40 feet at the west side. It contains little sand, except in the belt east of the Illinois Valley from Mauvaise Terre Creek northwards. Gastropods are abundant in it in many places. The lower, presumable Peorian, portion is typically grayish white to brownish gray or pale yellowish brown where fresh; the middle sandy zone shows similar colors; but the upper zone is more deep yellowish brown. Except where recent erosional exposure has plainly promoted weathering, the lower and middle portions are strongly calcareous, and rarely show much oxidation; but the upper 6 to 8 feet are leached in most places, and oxidation usually extends somewhat lower. As a result, the upper portion of the loess is commonly more deeply yellow brown to reddish brown.

Shelbyville time.--The only till of Wisconsin age to be deposited in the area was laid down by the edge of the Shelbyville glacier, near Peoria. It resembles Illinoian till except for the presence of nearly horizontal pink bands locally. Subsequently there is no distinct record of events until the Bloomington ice sheet advanced to a position just northeast of the border of the area.

The lack of weathering of the Peorian loess below the Shelbyville till indicates little lapse of time before the invasion of the Shelbyville glacier; and the Shelbyville and Bloomington glaciations were almost immediately followed by the deposition of the Tazewell loess, since tills of those ages are essentially

unweathered below the loess. Much of the loess above the Peorian was undoubtedly derived from Shelbyville outwash in the Illinois Valley, although at present it seems impossible to differentiate it from the overlying Bloomington loess.

Bloomington time.--Waters from the edge of the Bloomington ice sheet, which stood at Peoria for a long period of time,¹ carried outwash silt, sand and gravel down the Illinois Valley, producing a valley train which probably extended to and beyond its mouth. At Peoria, the outwash acted as a dam, backing the water as far up the valley as Joliet, to form a lake which endured thru Marseilles time (Lake Illinois). Similar material from the earlier glaciers of the Tazewell substage (Shelbyville, Cerro Gordo and Champaign) may have previously accumulated in the valley to an unknown depth and extent, and possibly the lower portion of some of the "Bloomington" valley train deposits described below are of those ages. Leverett,² however, believes that all the sand terraces in the Illinois Valley south of Peoria are of Bloomington age.

Sand and gravel terraces and bar-like masses in the lower Illinois Valley which stand well above the present floods constitute more or less degraded remnants of this valley train. These extend as far south as the valley of Sandy Creek, in Scott County, beyond which all traces of this material appear to have been swept away by later Wisconsin waters. Terraces of pink and gray stratified silts in the lower portions of tributary valleys represent a slack water facies of the outwash, and occur from near Peoria to the valley of Otter Creek in Jersey County. The surfaces of these terraces where not obviously subsequently altered by erosion or dune formation, show a rapid decline in elevation near the source, which decreases southwards so that in the lower two-thirds of the valley the decline is scarcely perceptible.

The best preserved large remnant of this surface is the highest level of the Peoria terrace, which slopes from 610 feet at the northeastern end to below 580 at the southwestern. The terrace sand and gravel is covered by 10 to 12 feet of typical late Bloom-

¹M. M. Leighton, "Glacial Lake Illinois and the Question of Post-Early Wisconsin Diastrophism in Northeastern Illinois." Unpublished manuscript in files of Ill. State Geol. Survey.

²Frank Leverett, "The Illinois Glacial Lobe," Monograph XXXVIII, United States Geol. Survey, 1899, p. 276.

ington loess. It is bounded on the west by Kickapoo Creek, the lower course of which was forced by the outwash to flow to the west of the original channel, cutting a narrow valley into bedrock. The remainder of the Peoria terrace has been degraded by Kankakee and Lake Chicago waters to much lower levels.

The largest single mass of Bloomington outwash is the Pekin-Chandlerville terrace, which lies between the Illinois and Sangamon Valleys, in Tazewell and Mason Counties. Its eastern portion preserves, at least locally, the original surface of the valley train and is covered by late Bloomington loess. Most of the terrace, however, appears to have been washed across by later glacial waters, probably from Lake Illinois, and later the Kankakee torrent and Lake Chicago outlet floods. These waters have cut terraces along the western edge, and the earlier ones may have dug the channels which run across its surface from northeast to southwest. Sand dunes are widespread on the terrace, occurring chiefly in great belts which in part probably correspond to bars on the original Bloomington flood plain and in part have been supplied with sand from areas swept by later glacial floods.

South of the Sangamon River, the Hagener and Spring Run Terraces, at the eastern edge of the Illinois Valley, appear to be portions of the Bloomington valley train which were somewhat lowered in surface elevation by streams in earlier post-Bloomington time. The other Bloomington sand remnants appear to have been degraded and dissected by Lake Chicago outlet waters, and are mostly bar-like in form. Sand dunes have developed over large portions of these areas.

The pink and gray slack-water terrace silts of the tributary valleys project to a height of at least 36 feet above the present alluvium. How far they extend below the latter is unknown; but the relationship indicates that in pre-Bloomington times the valleys were deeper than they are at present. This trenching is post-Illinoian, since the Illinoian drift is cut through as well as older drift and bedrock.

Three distinct sedimentary zones appear in these terraces. The lowest is a massive pink silt, which varies to gray or bluish gray locally; its base is concealed in all cases, and a maximum of 9 feet is exposed. It shows little bedding, contains a few gastropods, largely of fresh water types, and is separated from the overlying beds by an abrupt and apparently erosional contact,

which rises upstream in at least one of the tributary valleys.

The middle zone consists typically of an alternation of gray and pink silt layers, with thin streaks or lenses of sand and pebbles, chiefly in the lower portion. The greatest observed thickness was 10 feet. In terraces near the Illinois Valley, as at the mouths of Crane Creek in southern Schuyler County, and Lamarsh Creek in Peoria County, this zone becomes thicker and is composed almost wholly of pebbly sand. Up the tributary valleys, in contrast, it thins and disappears between the lower and upper zones.

The upper zone consists of grayish white to pale brownish or yellowish silt, attaining a maximum thickness of about 21 feet. It is calcareous except in the uppermost leached zone; and the uppermost portion appears indistinguishable from and probably is part of the late Bloomington loess. The lower part, however, is distinctly bedded, and locally includes pinkish material.

The pink color of these silts is characteristic of the Bloomington drift elsewhere.¹ Pink zones are also found in the Shelbyville till at Peoria, however, and although insufficient evidence was obtained to establish it, the writer believes that the lower massive pink silt was formed in pre-Bloomington time, as outwash from the Shelbyville and possibly the intervening Cerro Gordo and Champaign glaciers. The erosional contact above it and the concentration of sand and pebbles in the base of the overlying silt indicates a marked break between the two. The middle zone appears to correspond to the time of deposition of the sand and gravel of the Bloomington valley train in the Illinois Valley, when the Bloomington ice edge stood at Peoria. Its banded character may be of seasonal origin. The upper silt is thought to have formed after Lake Illinois came into existence, so that the pink Bloomington outwash silts settled in the latter, and the river carried only the more widespread grayish silts, which were perhaps largely swept in from the neighboring loess-covered slopes.

During Tazewell time, while the Illinois Valley was being aggraded by Shelbyville to and including Bloomington outwash, tributary streams were ponded, their gradients lowered and their lower courses alluviated with sediments of local and largely loessial

¹Leighton, "Glacial Lake, Illinois," op. cit. Also Leverett, "The Illinois Glacial Lobe," op. cit., p. 266.

origin. These beds have a thickness of at least 35 feet in present exposures, but the base is concealed in many instances, so that they may be much thicker. Commonly they cover the lower slopes of the loess-covered hills, and form a high-level alluvial fill in the smaller valleys. They overlies formations of all ages from the Wisconsin loess to bedrock. The calcium carbonate content of the silt varies greatly; some beds are as calcareous as fresh loess; others are completely leached; and most are intermediate. Color is even more variable; the different shades represent differing degrees and conditions of weathering. The fresher material resembles unweathered loess. The leached and colored zones constitute an irregular but definite bedding, the result of washing into place from the higher slopes where the weathering started. Zones of sand and pebbles appear in many exposures, particularly at the east side of the Illinois Valley, in one area in Greene County to the extent that the sand bodies appear to be dunes buried in the accumulating silts.

In many places this alluvial silt contains an abundance of woody material, such as carbonized twigs and logs. This phase is commonly somewhat sandy, and locally contains abundant gastropods. The color is bluish gray to dark grayish black. It commonly occurs in the bottoms of the present valleys, and in deeply cut exposures forms the base of the more widespread early Wisconsin alluvial silt just described. Curator Baker says of a gastropod fauna from this woody zone that he believes it is older than the Bloomington, and might be late Peorian or Shelbyville.

What is apparently the Peorian portion of the Wisconsin loess appears below these alluvial beds in some sections, and their position as an alluvial blanket along the base of the loess hills indicates their relatively younger age. However, in some exposures they are overlain by soft, fresh-looking loess of the late Bloomington type, and in others they have been subsequently degraded by erosion and are covered with abrupt erosional contact by later Wisconsin alluvium. In the lower portions of the tributary valleys the surfaces of these high-level alluvial silts accord with those of the pink and gray river-borne silt terraces, the upper portions of which, at least, are of Bloomington age. The woody phase appears to represent swamps, in which much plant material was preserved, which kept the iron compounds in a reduced and hence dark colored form. Thus the whole series appears to repre-

sent aggradation in the Tazewell substage of the Wisconsin, starting probably in Shelbyville time with the deposition of the woody silt, and progressively filling the tributary valleys to a height which was in accordance with the surface of the Bloomington valley train in the Illinois Valley.

Post-Bloomington and pre-Lake Chicago outlet time.--After the formation of the Bloomington valley train, the waters from Lake Illinois appear to have gradually cut a broad, shallow channel in the outwash surface, reducing the latter by some 15 feet. A corresponding reduction of level in tributary streams resulted in incision of a series of lower terraces in the Bloomington alluvial fill. This erosion surface is given the name of Hagerer, from the Hagerer terrace, in southwestern Cass County. Evidently conditions changed before the level had been developed very extensively, since the present-day remnants are scattered and imperfect. In most tributary valleys, the terraces have been largely or wholly destroyed by later erosion at lower levels.

After the Bloomington waters receded, sand from the valley bottom was blown onto the loess-covered upland to the east. Apparently this process went on during and after the formation of the Hagerer terrace, to the extent of forming great sheet-like layers of sand which are continuous from the terraces up the bluffs onto the upland, in one case to a distance of over a mile and a half east of the valley. Such sheets occur from the vicinity of Chandlerville south intermittently to the valley of Big Sandy Creek. They are irregular in outline and their surfaces are dune covered, with small inliers of loess projecting through locally. The sand is non-calcareous, and is somewhat more iron-stained and hence darker than the sand interbedded with the Wisconsin loess.

Near Chandlerville, the sand is continuous with and plainly derived from a sand area at a Lake Chicago outlet (probably Havana) level; near Bluff Springs and from there south to Arenzville it is similarly related to terraces at the Hagerer level. On the Griggsville Quadrangle, the extensive sheets are somewhat less directly but nevertheless plainly related to sand in the Naples bars or terraces, the surfaces of which stand at Lake Chicago outlet levels. On the Pearl Quadrangle there are two fairly large sheets at the north side of the valley of Apple Creek, one on a loess-covered upland and the other on a Bloomington terrace; and farther south, towards Eldred, there are several small ones. In these cases, there is no visible source for the sand on the now alluvium-

covered Illinois Valley flood plain. It is evident that they formed from Bloomington valley train sand which formerly filled the valley and which has subsequently been degraded by later floods and covered by alluvium.

It is possible that the formations of these sheets commenced as soon as the Bloomington waters receded enough to leave a dry sandy stream bed during part of the year. Probably later the higher portions of the valley, near the bluffs, became vegetation-covered; but the blowing of sand by the wind may have recommenced when Kankakee and Lake Chicago outlet waters washed over the sand areas, cleaning off the anchoring plants.

The Kankakee torrent¹ is credited with having cut the middle terrace at Peoria,² upon which most of the business area of the city lies. This terrace has a surface elevation of from 510 to 520 feet. A graphic comparison of this level with those of other terraces in this part of the Illinois Valley shows plainly that the Kankakee waters must have flooded much of the Pekin-Chandlerville terrace, particularly the northern and western portions. They may be responsible for some or all of the channels on its surface, and for the absence of loess on most of it. It is difficult, however, to identify the marks of their work with certainty, chiefly because of the later growth and movement of sand dunes.

Lake Chicago outlet time.--After Kankakee torrent waters receded somewhat, Lake Chicago outlet waters poured through the Illinois Valley, at lower levels. They further scoured out the valley, degrading portions of the Bloomington valley train and leaving three fairly distinct surfaces spaced some fifteen feet apart vertically. The uppermost, named the Havana, is preserved indistinctly near Pekin and much more clearly west of the Mackinaw River, along the northern edge of the Pekin-Chandlerville terrace, into which it is cut. The largest area lies in western Mason County, where dunes cover much of it. South of the Sangamon River valley it is not clearly identifiable, apparently merging into the terrace below.

The middle surface is the most extensive. It is given the

¹G. E. Ekblaw and L. F. Athy, "Glacial Kankakee Torrent in Northeastern Illinois," Bulletin Geol. Soc. of America, XXXVI (1925).

²H. B. Willman, personal communication.

name of the Bath terrace. It is fairly distinct in the vicinity of Pekin and Mapleton, and also near Havana, southwest of which it forms a low area along the southwestern tip of the Pekin-Chandlerville terrace. South of the Sangamon Valley it appears to form the surface of the bar-like Bloomington sand remnants in the vicinity of Beardstown and Meredosia. Sand dunes also occur on it.

The lower surface, referred to as the Cincinnati level, is definitely distinguishable only in the northern portion of the Pekin-Chandlerville terrace and in the vicinity of Mapleton across the valley to the west. It appears also to be represented in the surface of Duck Island, in Fulton County.

While the Lake Chicago outlet waters were cutting into the Bloomington fill in the Illinois Valley, the streams in tributary valleys were being correspondingly lowered, and were cutting headward to a new base-level. There are two distinct sets of terraces in them below Hager and Bloomington levels. The upper one, which apparently corresponds to the Bath terraces in the Illinois Valley, is very extensive, forming the flood plain in the upper portions of many valleys, and extending upstream beyond the Hager and Bloomington remnants. In the lower portions of the valleys, erosion at later levels has left this surface as a terrace, which slopes downstream and grades into the higher alluvium along the edge of the Illinois Valley. The lower of the two terraces is much less extensive, and is found only as an incomplete series of remnants which are being rapidly obliterated by erosion at the present level. Relative elevation indicates that it may correspond to the Cincinnati surface. Indistinct remains of a terrace a few feet higher than either of these may represent the Havana level, and there are a few fragments of a surface below the lower one.

The exact correlation of these levels of Lake Chicago outlet waters with Lake Chicago seems impossible; but it is suggested that the Havana level may be equivalent to the Westchester and/or Glenwood; the Bath, to the Calumet; and the Cincinnati possibly to the Toleston.

Alluvium appears in several places on the terraces in the tributary valleys which are correlated with the Bath level. Its upper surface forms the terrace level, but it overlies alluvial silt of the Bloomington type, with marked erosional contact, and differs from it greatly in lithology, for one thing in containing

more sand and pebbles. It was evidently formed contemporaneously with the incision of the terrace. Similar alluvium, in a similar relationship, was observed at one place on the lower, possibly the Cincinnati level, again apparently formed as the terrace was being cut, in late Wisconsin time.

In later Wisconsin and recent time alluviation has occurred along the sides of the Illinois and Sangamon Valleys, to levels well above the present river floods. The material, largely sandy silt rises to and above the level of the Bath terrace in many places, and even attains an elevation corresponding to the Hagener or Kankakee levels; but exposures show its alluvial nature. In this category are included alluvial fans; and also high alluvium built up among and behind the many bar-like masses of degraded Bloomington outwash sand in the eastern part of the Illinois Valley, in Cass, Morgan and Scott Counties.

There are many bar-shaped bodies of sand and gravel on the present flood plain of the Illinois River, above which they rise from a few to over 20 feet. The gravel bars are the higher ones; one near Bluff City appears to have been formed by Havana or earlier waters; the Duck Island and Matanzas bars appear to correspond to Cincinnati levels. The others, largely or wholly sand, and standing little above the flood plain, appear to be relics of a low and late stage of the Lake Chicago outlet waters, such as the Toleston and/or Hammond.

In later Wisconsin time and subsequently, the Illinois River has kept to the west side of its broad valley along the Pekin-Chandlerville terrace and southward as far as Naples. The familiar factor of deflection to the right of all currents in the northern hemisphere may be partly or wholly responsible. However, the surface of the Bloomington valley train in the Pekin-Chandlerville terrace slopes slightly westward as well as southward, which is probably because it was in part built up of outwash contributed from the east by the Mackinaw River. Whatever the cause, the dwindling river of later Tazewell times took this right hand course, in which it was followed by Kankakee and Lake Chicago outlet waters, in the Cary and Kankato substages of the Wisconsin.¹ These later floods have evidently been carving into the west wall

¹M. M. Leighton, "The Naming of the Subdivisions of the Wisconsin Glacial Age," Science, LXXVII, No. 1989 (February 10, 1933), 168.

of the Illinois Valley, as indicated by several bedrock exposures lying along the west side of the valley bottom, above the lower parts of the flood plain and its alluvium. Outcrops at the west end of the Bluff City gravel bar, on the Chandlerville Quadrangle, and in Duck Island and in the northeast corner of section 13 of Liverpool township on the Manito Quadrangle are examples. The retention of this western channel by the present river is perhaps influenced by the fact that the drainage area and hence the tributaries are larger along the east side of the valley.

